**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Introduction to Meteorology**

**Homework #3 (Chapters 5 and 6)**

**Due: Friday, November 7**

1. Clouds form as air \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, expands and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 until the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is reached and condensation occurs.

2. a) If the atmosphere is “stable”, when we lift a parcel of air, what will happen?

 b) How about if the atmosphere is “unstable”?

3. a) What process occurs in rising air parcels that are cooling at the dry adiabatic

lapse rate that causes them to begin to cool at the saturated adiabatic lapse rate?

 b) Why is the saturated lapse rate less than the dry rate (~3.3**°**F/1000 ft vs.

 5.5**°**F/1000 ft)?

4. a) To know the stability of the atmosphere we must know both the adiabatic lapse

rates and the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ lapse rate.

 b) How do we determine this lapse rate?

 c) Why do we need to know both rates to know if the atmosphere is stable or not?

5. What types of clouds tend to form in a stable atmosphere?

6. The atmosphere is “stable” when the environmental lapse rate is small, that is,

when there is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ between the surface air and the air aloft. Therefore, the atmosphere “stabilizes” when the air aloft \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and/or the surface air \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

7. The most stable type of atmosphere is one in which the temperature actually

increases with height. This is called an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. When there is large scale sinking in the atmosphere (high pressure systems) this is called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

8. The atmosphere “destabilizes” when the air aloft \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and/or the

air at the surface \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Therefore, on a sunny day, the atmosphere will tend to destabilize during the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ [time of day].

9. a) What type of instability, in which the environment is stable with respect to

rising unsaturated (clear) air but unstable with respect to rising saturated (cloudy) air, occurs commonly in the troposphere?

 b) What types of clouds tend to form in this type of atmosphere?

 c) What is the elevation where these clouds begin to form (cloud base) called?

10. What are the four mechanisms which cause air to rise (to be lifted or forced

 upward) and thus are responsible for the formation of most clouds?

11. In one of these mechanisms, convection, stability plays an important role. If the

atmosphere is stable the clouds will have little vertical development and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ clouds will tend to form. If, however, the atmosphere is conditionally unstable \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and, possibly, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_clouds will tend to form.

12. When moist air is forced upward by a mountain range (e.g. the Sierra Nevada

and Cascades along the west coast) there will tend to be considerable rainfall on the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ side as air \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and very little rain, as air \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ side. Regions to the leeward side of these ranges are called “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_”.

13. a) What are the two general methods of precipitation formation?

 b) Which is more prevalent in middle and high latitudes and which is more

 prevalent in the tropics?

 c) Why?

14. In the ice-crystal (Bergeron) process, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ grow at the

expense of the surrounding \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ due to a difference in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ surrounding them.

15. Most rain that falls in middle latitudes, even in summer, even in thunderstorms,

 starts as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

16. What is it called when precipitation falling from a cloud evaporates before it

 reaches the ground?

17. Showery (brief and sporadic) precipitation tends to fall from

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ clouds whereas continuous precipitation, covering a larger area tends to fall from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ clouds.

18. a) Can it snow if the surface temperature is above freezing?

 b) Why or why not?

19. How do we measure the intensity of snowfall?

20. What is the difference between sleet and hail?

21. Freezing rain forms as rain falls through a thin layer of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 near the surface which causes the drops to become \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

 These drops then freeze \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when they reach the

 surface, forming an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

22. a) What is the “average” ratio of snow to rain accumulation (snow water

equivalent)?

 b) Why is this ratio so much higher in dry and cold regions (e.g. Rocky

 Mountains)?

23. What is standard (not Doppler) radar used to measure?

24. Differential \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of earth’s surface results in horizontal

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ differences. It is these differences which generate the horizontal movement of air, which is called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ , with air moving (being forced) from regions of higher \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to regions of lower \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

25. a) What is an instrument that measures atmospheric (air) pressure called?

b) Which type is most commonly used today?

c) What is the standard pressure measurement utilized in meteorology today?

26. Why is a steady drop in atmospheric pressure frequently associated with

 deteriorating (worsening) weather?

27. What are lines connecting points of equal pressure, drawn on a weather map,

 called?

28. A warm air column will be associated with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ pressure aloft and a

cold air column will be associated with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ pressure aloft. Therefore, on upper-air maps, high pressure tends to be located to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and low pressure to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

29. a)What are the four forces that influence the wind?

 b) Which of these is responsible for ***generating*** the wind?

30. Why do closely spaced isobars on a weather map indicate high winds?

31. Coriolis force is due to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. In

 the Northern Hemisphere, this force causes air to turn to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

32. Geostrophic balance, a balance between \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ results in wind (geostrophic wind)

 that blows\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to the isobars at a constant speed with

 lower pressure to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and higher pressure to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 in the Northern Hemisphere above the friction layer (above ~ 3000 feet).

33. An additional force, centripetal force, permits wind (now called gradient wind)

to continue to flow in the manner of the geostrophic wind (relative to the isobars). This results in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ flow around a cyclone (low pressure center) and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ flow around an anticyclone (high pressure center) in the Northern Hemisphere.

34. As a result of all this force/balance crap, on upper-level maps in middle latitudes

wind direction (flow) is generally \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the Northern Hemisphere and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the Southern Hemisphere.

35. a) What additional force influences the wind at the surface?

 b) How does this affect the speed and direction of the wind?

 c) As a result, in the Northern Hemisphere (NH) surface winds blow

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ a low pressure center and

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_a high pressure center.

36. Air flowing in toward a surface low results in a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(crowding together) of air molecules at the surface and a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (spreading apart) or air at the tropopause which causes air to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, thus the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ weather associated with surface low pressure systems.

37. Pressure gradient force in the vertical is balanced by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

 This balance is called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

 This balance exists most of the time in the atmosphere and limits

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ motion.

38. Wind direction is the direction \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

39. In the northeastern U.S. the prevailing wind is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in

 winter and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_in summer.

40. The amount of force exerted by the wind over an area increases as the

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the wind velocity. Therefore, if the wind velocity doubles, the force it exerts on an object goes up by a factor of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.